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ORIGINAL ARTICLE

# Comparison study of a long-pulse pulsed dye laser and a long-pulse pulsed alexandrite laser in the treatment of port wine stains

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**Abstract**

*Background*: Port wine stains (PWSs) are commonly treated by the pulsed dye laser. Recently, a long-pulse pulsed alexandrite laser was used to treat bulky vascular malformations. *Objective*: In the present study, we compare the efficacy and complications of the long-pulse pulsed dye laser (LPPDL) and the long-pulse pulsed alexandrite laser (LPPAL) in the treatment of PWSs. *Methods*: Eleven patients with Fitzpatrick skin types III–IV were enrolled in this study. One section of each patient's PWS was treated with LPPDL and another section was treated with LPPAL. The patients' PWSs were evaluated for efficacy of elimination of erythema and for treatment-related side effects. *Results*: Both LPPDL and LPPAL treatment are effective in the treatment of PWSs. Hyperpigmentation was seen in two areas treated with LPPDL and in three areas treated with LPPAL. Hypopigmentation was seen in one area treated with LPPAL, but not in any of the areas treated with LPPDL. There was no scarring. *Conclusion*: LPPAL works best with hypertrophic, purple PWSs, while LPPDL yields better clinical improvements with the flat, pink PWSs. Targeting of deoxyhemoglobin, deeper penetration, and higher fluence may explain the effectiveness of LPPAL in purple, hypertrophic PWSs. However, there is a risk of dyspigmentation when using the LPPAL.

**Key words:** *Long-pulse pulsed alexandrite laser, long-pulse pulsed dye laser, port wine stains*

## Introduction

Port wine stains (PWSs) are commonly treated by the pulsed dye laser (PDL) as standard therapy (1). However, in the majority of cases, complete clearance cannot be achieved and a significant proportion of lesions are resistant to this treatment. In recent studies, the long-pulse pulsed alexandrite laser was used to treat different vascular lesions (2–5). In the millisecond mode, this laser has been widely used for hair removal and for leg vein treatments. It may have an important role in the treatment of bulky malformations and mature PWSs. These lesions are typically more resistant to the PDL due to the predominance of larger and deeper vessels and a higher content of deoxygenated hemoglobin (6,7). Longer wavelengths penetrate deeper, allowing targeting of deeper vessels. However, higher fluences are needed, which in turn increases the potential for epidermal heating due to competitive absorption by epidermal melanin. This is especially important in darker skin patients because of the increased risk of side effects, such as dyspigmentation and scarring. The aim of our study is to evaluate the clinical efficacy and complication rate when utilizing these two lasers in the treatment of Asian patients with PWSs.

## Materials and methods

Eleven patients with Fitzpatrick skin types III–IV were recruited in this study. The participants ranged from 1 to 47 years of age; three patients were male and eight patients were female. Signed written consent forms were obtained from patients or their guardians before participants entered the trail.

### *Laser treatment*

A single operator (TK) treated all the participants. Each patient had one section of his or her PWS treated with the long-pulse pulsed dye laser

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(LPPDL) and another section of the PWS treated with the long-pulse pulsed alexandrite laser (LPPAL). A LPPDL (model V-beam; Candela Corporation, Wayland, MA, USA) with a wavelength of 595 nm and a LPPAL (model GentleLase; Candela Corporation) with a wavelength of 755 nm were used. In order to compare these two lasers, we used a spot size of 7 mm and a pulse duration of 3 ms with the LPPDL, and a spot size of 8 mm and a pulse duration 3 ms with the LPPAL. The fluence that resulted in a desirable clinical end point with each laser was used. In the LPPDL site, an end point of uniform purple without whitening was selected, with a fluence between 13 and 15 J/cm$^2$. In the LPPAL site, the fluence was between 35 and 50 J/cm$^2$, with the end point being an ash grey appearance. Postoperatively, antibiotic ointment was applied to the treatment area. Participants were advised to avoid sun exposure, scrubbing or abrasion of the lesion after laser treatment.

*Assessment of response*

Patients were monitored postoperatively at 1, 4 and 12 weeks after laser treatment. A research assistant took clinical photographs in a standard manner before laser treatment and at each follow-up appointment. The degree of elimination of erythema due to laser treatment was assessed with erythema reflectance spectrometry (Dermaspectrometer; Cortex Technology, Hagland, Denmark). Two independent, blinded observers reviewed the clinical photographs and assessed the degree of complications, such as scarring, hypopigmentation, and hyperpigmentation. The examination took place with the aid of an operating theater light, with scarring defined as hypertrophic, raised, or atrophic. Pigmentary changes were defined as hyper- or hypopigmented when compared with the adjacent area of normal skin.

## Results

The mean number for the erythema index was 22.4 ± 11.2 in the LPPDL site and 20.6 ± 7.53 in the LPPAL site, compared with 26.5 ± 9.9 in the pretreatment lesions (Figure 1). The lesions achieved more lightening with LPPAL than with LPPDL, but the difference was not significant (Figure 2). LPPAL works best with hypertrophic, purple PWSs; while LPPDL yields better clinical improvements with the flat, pink PWSs (Figures 3 and 4). Hyperpigmentation was seen in two out of the 11 areas treated with LPPDL and in three areas treated with LPPAL. Hypopigmentation was seen in one out of the 11 areas treated with LPPAL, but not in any of the areas treated with LPPDL (Table 1). There was no scarring.

## Discussion

PWSs are congenital, hypervascular malformations which produce a dark pink appearance on the surface of the skin and which may evolve into nodular, purple lesions in adulthood. For nearly two decades, the PDL has been the treatment of choice for PWSs (8–15). Although almost all PWSs lighten after a series of PDL treatments, most PWSs cannot be removed completely, even after six to 10 treatments, and further treatment often yields no improvement. Dark, mature PWS lesions can extend 3–5 mm deep (11,16), while the PDL, with a wavelength of 585–600 nm, extends to only 1–2 mm deep. The PDL does not penetrate deep enough to target deep dermal vessels (17). Also, it is

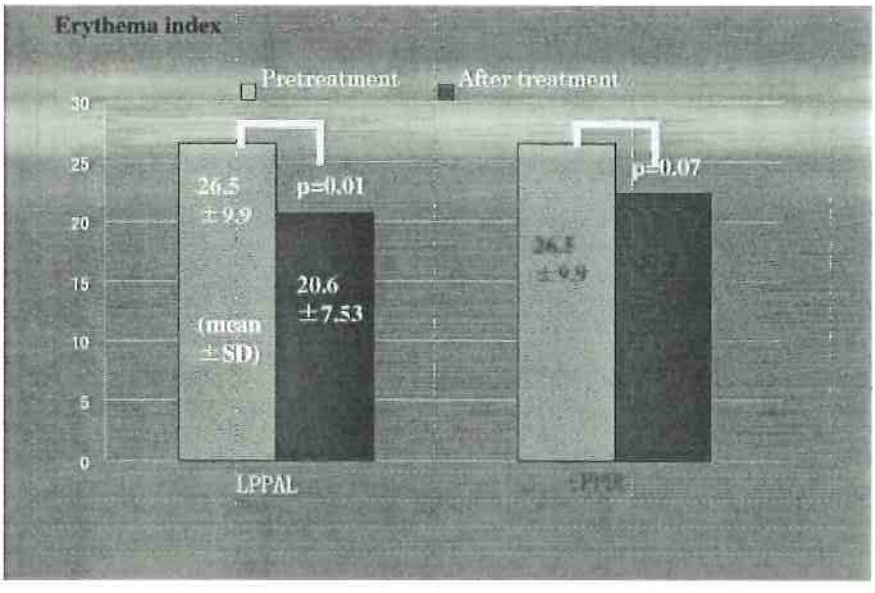


Figure 1. The improvement of erythema after laser therapy.

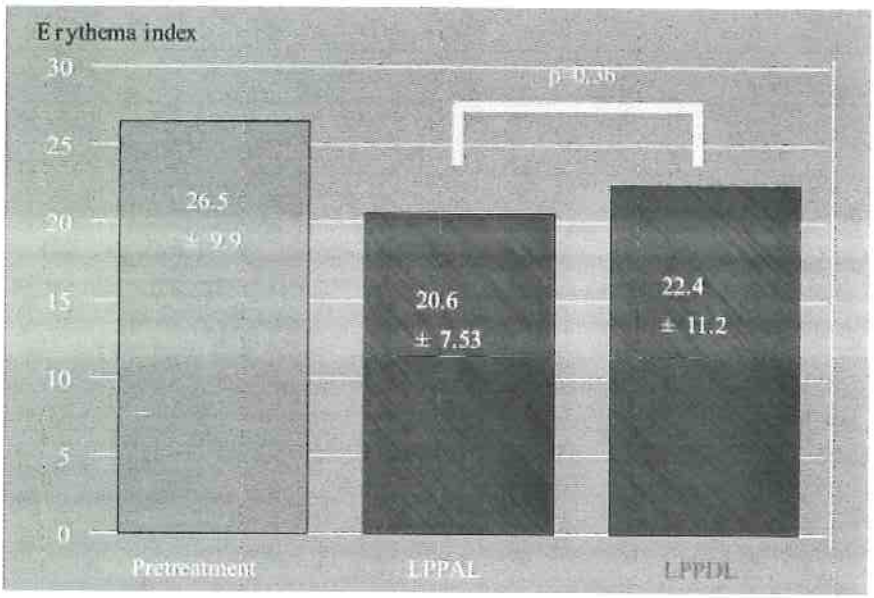


Figure 2. Comparison of erythema improvement after treatment with each laser.

recognized that the ectatic capillaries in PWSs range in diameter from 10 to > 100 $\mu$m (18). These vessels may be too large in diameter or may carry blood too quickly; therefore, sufficient energy cannot be generated to damage the vessels irreversibly (10). These large, partially coagulated vessels are probably not destroyed and subsequently regenerate. Likewise, no coagulation of deeper vessels was noted in PWSs with multiple vascular layers because almost all of the laser light is absorbed in the more superficial vessels. Furthermore, Kane et al. (11) also suggested that the formation of a fibrous shield in the upper papillary dermis (generated by destruction of superficial vessels from previous PDL treatments) might progressively obstruct laser light from penetrating into the deeper dermal vessels.

To counter these difficulties, near infrared wavelength 755-nm LPPAL have been explored for the treatment of PWSs (6). No et al. used a 3-ms alexandrite laser with dynamic cooling to treat three patients with hypertrophic PWSs, using fluences ranging from 30 to 85 J/cm$^2$. All lesions significantly lightened, without side effects.

The effectiveness of LPPAL treatment may be caused by several phenomena. The longer wavelength of the LPPAL (755 nm) results in greater absorption of deoxyhemoglobin when compared with oxyhemoglobin (19). Therefore, targeting of deoxyhemoglobin, which is prevalent in hypertrophic, purple PWS lesions, with the LPPAL results in higher clearance rates when compared with the LPPDL.

Deeper penetration by the longer wavelength of the LPPAL is another reason for its effectiveness. With the longer wavelength of 755 nm, there is greater depth of penetration of the laser energy, and

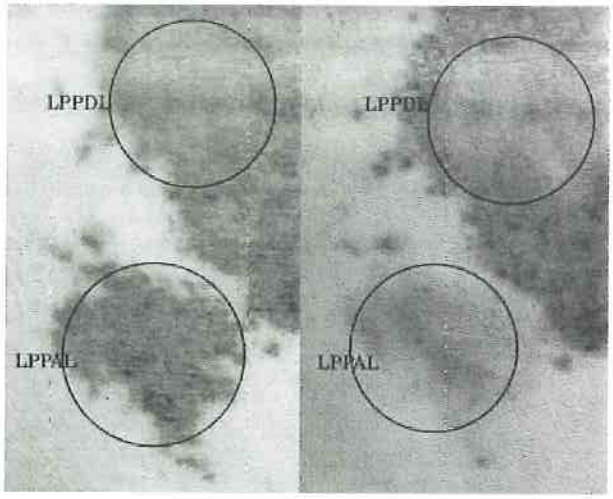


Figure 3. Left-hand side is before treatment and right-hand side is three months after treatment: case 1.

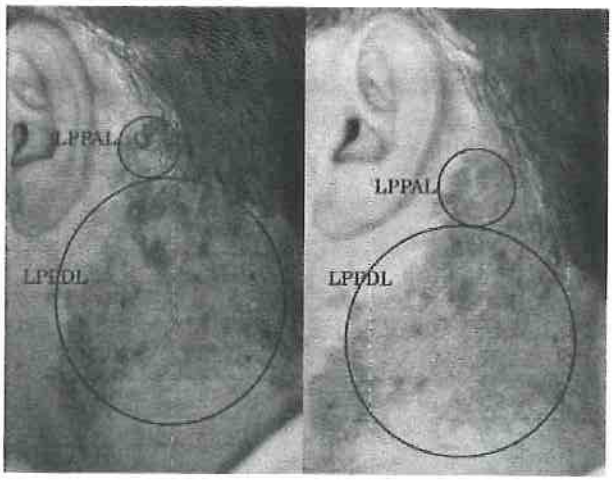


Figure 4. Left-hand side is before treatment and right-hand side is three months after treatment: case 2.

Table 1. Complications ($n$=11).

| | Hyperpigmentation | Hypopigmentation | Scar formation |
|---|---|---|---|
| LPPDL | 2/11 | 0/11 | 0/11 |
| LPPAL | 3/11 | 1/11 | 0/11 |

larger and deeper vasculature can be targeted. Longer wavelengths are also able to penetrate ectatic capillary walls more effectively and thus are more effective at heating the center of the vessels.

In addition, the higher fluences used with the LPPAL contribute to its effectiveness. When similar spot sizes, pulse durations, and DCD (Dynamic cooling device) parameters were used with these two lasers, the fluence that resulted in the clinical end point that we were looking for in the treatment of the PWSs was quite different. In our study, the maximum fluence was 15 J/cm$^2$ in the LPPDL treatment sites, compared with 50 J/cm$^2$ in the LPPAL treatment sites. Therefore, when we used the LPPAL (with much higher fluences) in the treatment of purple, hypertrophic PWSs, the resultant bulk dermal heating may be more effective.

However, higher fluences increase the potential for epidermal heating due to competitive absorption by epidermal melanin, especially in dark-skinned patients. In our study, there was the possibility of dyspigmentation in the patients with darker skin treated with the LPPAL.

## Conclusion

In this study, we found that both the LPPAL and the LPPDL are effective for the treatment of PWSs. The LPPAL acts well with the hypertrophic, purple PWSs, while the LPPDL yields more improvement with the flat, pink PWSs. Clinically, when treating patients with darker skin types, caution is warranted because there is a possible risk of dyspigmentation after laser therapy. Further studies with larger patient numbers are necessary to optimize this treatment.

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